Carbonated soft drink acceptability of college students: impact of glass bottle or aluminium can packing

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Summary

This study compared aluminium concentrations and acceptability by college students of carbonated soft drinks recently packaged in aluminium cans or glass bottles with carbonated soft drinks stored in aluminium cans for six months. Aluminium concentrations of beverages packaged in aluminium cans were higher than those packaged in glass bottles and increased with storage time ($p=0.013$). An untrained sensory panel of 95 American college students evaluated blind samples of carbonated beverages. While flavour of the beverages differed, subjects identified the glass bottle packed beverage as having the most and the stored aluminium can beverage as having the least metallic flavour ($p<0.05$). Thus, the metallic flavour as identified by panellists did not relate to aluminium concentration.

Key Words: carbonated soft drinks, taste, packaging, flavour

Introduction

The lifestyles of the American consumers have changed and so too have their preferences within the liquid refreshment market (1-4). Daily intake of carbonated soft drinks among college students has increased tremendously since 1977 (1). Consumption of such drinks are also increasing elsewhere, including developing countries. College students in the United States represent approximately 29% of the food consumers, and the accessibility of carbonated soft drinks in college cafeterias, institutions, restaurants, food stores, and fast food outlets has contributed to the consumption of these beverages (1,5).

Carbonated soft drinks generally are packaged in three different packaging materials; glass bottles, plastic bottles and aluminium cans. Aluminium is used extensively in packaging because of its low specific weight, recyclability and its compatibility with printing processes which enable it to have a decorative appearance (6). Previous research has indicated that acidic foods stored or cooked in aluminium containers enhance the leaching of aluminium into foods, thereby increasing food aluminium content (7-10). Although controversial, exposure to aluminium has been implicated in the aetiology of Alzheimer's disease (11-15), dialysis dementia (15-16) and dialysis osteodystrophy (17). The objective of the current study was to compare the aluminium concentrations and taste acceptability of soft drinks packaged in aluminium cans or glass bottles for varying periods of time.

Materials and Methods

Prior to the study, a questionnaire was mailed to 5400 undergraduate students at the University to identify popular carbonated soft drinks (pop) and preference of packaging (glass, aluminium, or plastic). Of the 5400 questionnaires mailed, a total of 5022 questionnaires (93%) were returned. Results of the survey revealed that 87% of the students had a greater preference for cola soft drinks. Seventy-five percent preferred soft drinks packaged in aluminium cans, 23% in glass bottles and 2% in plastic bottles. Based on these results, all of the regular cola carbonated soft drinks intended for the taste acceptability study were packaged in aluminium cans or glass bottles and were purchased from a nearby processing plant. Three different brands of soft drinks for which both aluminium can and glass

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bottle packaging were available were used. All the beverages were produced at the same plant and were processed at the same time. The age of the beverages was identified from the code number on the container as explained by the manufacturer. Soft drinks were divided into 3 groups: freshly processed soft drinks packaged in aluminium cans; freshly processed soft drinks packaged in glass bottles, and soft drinks packaged in aluminium cans which were stored for six months at room temperature.

Aluminium concentrations of soft drinks were determined in triplicate using atomic absorption methodology (Varian Techtron Atomic Absorption Spectrometer, Model 1275). The procedures used to prevent trace element contamination, prepare and analyze samples were similar to those reported previously (17-18).

Taste acceptability of soft drinks was judged by a panel of 95 European American student volunteers who were recruited by an advertisement placed in the campus newspaper. There were 40 males and 55 females. Their ages ranged from 17-25 years (mean = 23 ± 3.5). All of the panelists were non-nutrition undergraduate students at Ball State University, Indiana, who had no previous experiences as palatability panelists. The procedures of the panel evaluation were explained before testing the beverages. The kind and frequency of beverage consumed on a weekly basis were also identified.

Using a written questionnaire, subjects were asked to indicate which of the following beverages they most frequently consumed: milk, coffee, iced tea, soft drinks or fruit juices. They were then asked to indicate how many times per week they consumed their preferred beverage and their preference for soft drink packaging (glass bottle, plastic, aluminium can, other).

A three ounce (94 ml) serving of the three different brands (A,B,C) of each test beverage type (soft drink in aluminium can, glass bottle and soft drink in aluminium can stored for six months) were chilled and poured into individual styrofoam cups, which were coded using symbols, and randomly presented to the subjects to enable appropriate blind testing of the samples.

To avoid contamination, subjects were seated at individual tables, and no communication was permitted between panelists during the study. Subjects were then asked to taste each of the 9 samples and to indicate which sample they liked the best. Subjects rinsed their mouth thoroughly before the test and could rinse their mouth as wanted thereafter. In addition, they were asked to indicate which was from a newly packaged aluminium can, which was from glass-bottled packaging and which from six month stored aluminium cans. Using a forced ranking test, subjects were asked to indicate the intensity of the metallic flavour; the most metallic tasting sample, the intermediate metallic tasting sample, and the least metallic tasting sample. Since the meaning of the term "metallic" is not universal among all participants and may create a great deal of "noise" with regard to this particular aspect of the test, the following definition was provided to all subjects: A taste composed of or resembling that of metals is called metallic.

Since the participants used in this study were inexperienced taste panelists and in order to obtain greater precision in their ability to identify metallic differences, soft drinks stored in glass bottles for six months was not offered to the taste panelists. Statistical significance of relationship in beverage preference, frequency of consumption, flavour, packaging and acceptability were determined by Chi-Square analysis and by Test of Sign (19).

Results and Discussion

As shown in Table 1, mean aluminium concentrations of glass bottled soft drinks, newly packaged canned soft drinks and stored canned soft drinks were 0.143 ± 0.002, 0.212 ± 0.016, and 0.247 ± 0.0212 mg aluminium/l, respectively ($p<0.05$).

Table 1. Mean aluminium concentrations of soft drinks as determined by packaging

Packaging	Mean Aluminium Concentrations[a]
Glass	0.143 ± 0.002
Stored aluminium can	0.247 ± 0.012
Newly purchased aluminium can	0.212 ± 0.016

[a] $P<0.05$

Of the choices offered, 56% of the 95 panelists indicated that their choice of beverage was carbonated soft drinks. Eighteen percent, 14% and 12% of the 95 panelists indicated their usual choice of beverage were milk, iced tea and fruit juice respectively. Of the 56% who drank soft drinks, 31% could be categorized as frequent consumers in that they consumed more than eight servings per week and 18% could be categorized as infrequent consumers in that they usually drank one to two servings per week (Table 2). Of the individuals consuming carbonated soft drinks, 62% indicated that they preferred to consume canned soft drinks and 38% indicated they preferred bottled soft drinks.

Table 2. Usual number of times/week of consuming beverages of choice

Number of times times per week	Subjects consuming beverages				
	Milk	Coffee	Iced Tea	Carbonated Soft Drinks	Fruit Juice
1–2	4	0	0	18	5
3–4	0	0	2	1	14
5–6	8	0	4	0	0
7–8	0	0	0	0	5
> 8	0	0	3	31	0

As shown in Table 3, 44% of the subjects preferred the taste of soft drinks packed in newly purchased aluminium cans and 38% preferred the taste of the beverage which had been stored for six months and had the higher aluminium content ($p=0.24$). This suggests that the panelists either didn't care or couldn't identify a more matallic flavour. Only 18% of the panelists preferred the glass packaged beverage (Glass vs New Can, $p<0.5$; Glass vs Old Can $p=0.32$).

Table 3. Best liked beverage by taste as determined by packaging

Packaging	Number of Panelists	%
Glass	17[b]	17.9
Stored aluminium can	36[ab]	37.9
New aluminium can	42[a]	44.2
Total	95	100.0

Values with no repeated letter superscripts are significantly different from one another ($p<0.05$) by Test of Sign.

Panellists were asked to rank each sample from being most metallic, intermediate, to least metallic on flavour (Table 4). In the metallic characteristic category, the glass packaged beverage was judged most metallic, while the stored aluminium can beverage was judged least metallic in flavour ($p<0.05$).

Table 4. Metallic flavour in beverage as determined by packaging

Packaging	Number of Panellists Selecting		
	Most	Intermediate	Least
Glass	48[a]	28[ab]	19[b]
Stored Aluminium Can	17[b]	30[ab]	48[a]
New Aluminium Can	30[ab]	37[ab]	28[ab]

Values of 95 subjects with no repeated letter superscripts are significantly different from one another ($p<0.05$) by Test of Sign.

In the least metallic flavour category, as would be expected these figures were nearly reversed, with stored aluminium can beverage selected by forty-eight panelists and glass container beverage being selected by nineteen panelists ($p<0.05$). These results imply that there is a difference in flavour due to packaging and storage, but this difference is not easily recognizable as being metallic.

Subjects were asked to judge which beverage was packaged in which container type. When the beverage packaged in stored aluminium cans was judged, 47 (49%) panelists indicated that it was the glass container beverage and only 20 (21%) indicated the correct response ($p<0.05$). When the glass bottled beverage was served, 43 (45%) of the panelists indicated that it was the old aluminium can packaged beverage and 23 (24%) correctly judged it to be the glass packaged ($p<0.05$). When the newly purchased aluminium can beverage was judged, 41 (43%) of the subjects correctly identified it while 28 (29%) of the subjects each identified it as old aluminium can beverage or glass bottle beverage ($p<0.05$). Therefore the group as a whole was unable to correctly identify packaging of beverages when served as blind samples. More importantly, to a significant degree, misidentifying of sample was the rule rather than the exception.

When responses of subjects by gender were examined using Chi-Square analyses, no significant differences among female judges were demonstrated although female judges tended to be more discriminating than the male. More female subjects than male subjects fell in the frequent soft drink category.

Therefore, Chi-Square analyses were done using the categories frequent soft drink consumers (>8/week), infrequent soft drink consumers (1-8/week), and other beverage preferers. There was no statistically significant difference between frequent soft drink consumers, infrequent soft drink consumers and other beverage preferrers in choice of most metallic and least metallic flavour. However, in the intermediate metallic flavour category, there was a statistically significant difference among the three beverage consumers ($p<0.005$). This indicated that the frequent soft drink consumers, infrequent soft drink consumers and other beverage consumers were able to identify the intermediate metallic flavour from the newly purchased aluminium can better than the beverage in the stored aluminium can or glass bottle.

In conclusion, metallic flavour apparently is not a good indicator of aluminium concentration of soft drinks. Females consumed more carbonated soft drinks than males. In flavour evaluation tests, neither males nor females were able to identify the packaging material used for the beverage. The higher acceptability of aluminium canned carbonated beverages in comparison to glass bottled ones may be the result of the more common use currently of the type of packaging for carbonated soft drink beverages.

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